Renewable Energy in Danish Municipalities - an Evaluation of The Planning Framework for Wind Power

Sperling, Karl; Hvelplund, Frede; Mathiesen, Brian Vad

Published in:
CD PROCEEDINGS

Publication date:
2009

Document Version
Publisher's PDF, also known as Version of record

COVER LETTER WITH KEYWORDS

KEYWORDS

Wind power, Planning, Political framework, Siting, Wind power subsidies, Local engagement, Compensation, Community ownership

Renewable Energy in Danish Municipalities – An Evaluation of the Planning Framework for Wind Power

Karl Sperling*
Department of Development and Planning
Aalborg University, Aalborg East, Denmark
e-mail: karl@plan.aau.dk

Frede Hvelplund
Department of Development and Planning
Aalborg University, Aalborg East, Denmark
e-mail: hvelplund@plan.aau.dk

Brian Vad Mathiesen
Department of Development and Planning
Aalborg University, Aalborg East, Denmark
e-mail: bvm@plan.aau.dk

ABSTRACT

Wind power is a maturing technology that in a number of countries is likely to contribute a major share to fully renewable energy systems. Denmark has a comparably long history of wind power development and is planning to continue expanding the existing capacity. If a large-scale penetration of wind power is to be achieved, an integrated framework is needed that can respond to the associated challenges. This paper argues for adopting an integrated macro perspective when evaluating and building frameworks to support wind power development. This macro perspective is applied to the case of Denmark, and more specifically to concrete wind power projects in the region of Northern Jutland. The results suggest although certain elements in the legislation have been improved, the feasibility of wind power projects cannot be guaranteed, and there is a tendency to exclude smaller turbines from the development.

1. INTRODUCTION

Modern energy systems are currently beginning to meet a number of challenges, a process which is leading to the transition towards new ways of producing and consuming energy in the near future. Climate change, security of supply and depletion of natural resources range among the arguments in a public debate concerned with the introduction of alternative energy strategies worldwide. There seems to be growing consensus among experts and decision-makers that such alternative energy strategies entail more efficient, less-consuming energy systems based on renewable energy sources. In line with that, the Danish government has the long term vision of a fossil fuel free Denmark and the goal of 30% of the national energy consumption to be covered by renewable energy production by 2025 [1]. From a techno-economic point of view, Lund and Mathiesen [2] have demonstrated the possibility of 100% renewable energy systems within the next 40 years for the case of Denmark. Having a comparably long tradition of developing and implementing wind power technology along with good wind conditions and in general high public support, Denmark will in this context

* Corresponding author

continue to focus on promoting wind power as the main electricity producing technology. Currently, the Danish Transmission System Operator (TSO) is planning to develop the transmission system to take a 50% penetration with wind power into account[1]. It is estimated that this will correspond to around 6,000 MW in total capacity, of which around 3,000 MW can be installed onshore and the remaining 3,000 MW can be installed in off- and in-shore wind farms [3, 4]. The new onshore turbines can thereby approximately replace all of the existing capacity, which in 2007 was around 3100 MW [5]. Due to the increasing size and capacity per turbine it can be possible to replace the currently installed 5,200 turbines by around 1,000 larger turbines, which together with the new offshore capacity can result in a total number of around 1,500 installed wind turbines in 2030 [4].

Altogether this will mean that while the overall amount of wind turbines in the landscape is going to decrease, the local impacts due to larger turbines are going to increase [6]. The sensitivity of those sites with regard to visual and noise impacts by the turbines as well as natural and cultural concerns requires careful evaluation. Finding appropriate sites for wind turbine development therefore appears to be one of the main challenges with regard to developing the renewable energy system in Denmark. The possibility of installing smaller turbines additionally or instead of a number of the larger wind turbines seems not to be under consideration in the current debate. Installing smaller turbines would possibly mean a more straightforward siting process. Since the Local Government Reform in 2007 the selection of appropriate wind power sites and carrying out the corresponding local planning process has been the task of the 98 Danish municipalities. This has opened up for the potential of a more flexible and decentralised planning process, in which the municipalities have gotten the authority to promote and plan the expansion of wind power locally. Along with an improved national support scheme for wind power, which came into effect in early 2008, this forms the basis for accelerating wind power development in Denmark.

1.1 Conditions improving the implementation of wind power

The theoretical starting point for this paper is the development of a macro perspective on the conditions that together can improve the implementation of wind power in general. We use this macro perspective both to structure the paper and make possible a more focused analysis of certain elements in it. Innovation research has long suggested that technological innovation is not only about technical optimisation (i.e. invention), but also adopting new technologies in the wider society (i.e. diffusion) [7,8]. Regarding wind power, it seems that especially the second process has received too little attention, as the experiences with high numbers of failed wind power projects in a number of European countries suggest [9,10]. Recent research conceptualises this “adoption process” as being dependent on a number of interrelated factors. Wüstenhagen et al. [11] argue, for instance, that renewable energy not only requires appropriate economic support (market acceptance), but that the public support of those technologies needs to be ensured simultaneously, both on a local (community acceptance) and national scale (socio-political acceptance). In Figure 1 we illustrate our view on the factors that condition this adoption, or rather, implementation process.

[1] The integration (and/or socio-economically feasible export) of fluctuating energy sources, such as wind power, is one of the main technical challenges to be overcome in future energy systems. Several studies have based on energy systems analyses demonstrated how such integration could look like [12, 13].

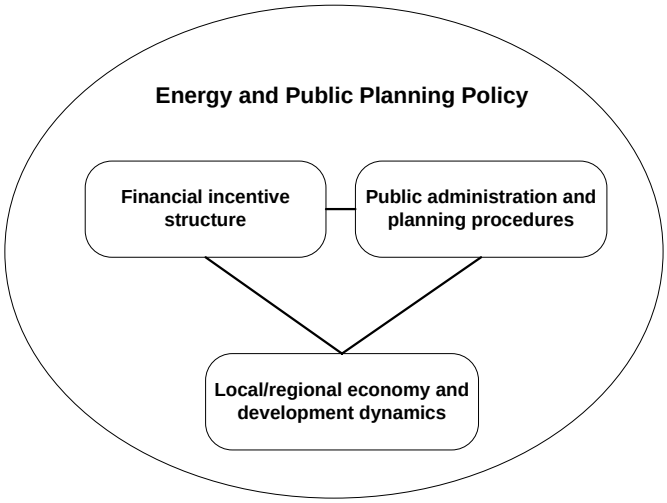

Figure 1. A macro perspective of the conditions influencing the implementation of wind power. It is embedded within national policy making and can be described as the balanced interplay of elements that ensure a stable, economic basis, smooth planning and administration and positive effects on a more local development level.

Three integrated sets of factors determine the outcomes of wind power projects according to this macro perspective. On the one hand, there needs to be a *financial incentive structure* in place that can provide a sound economic basis for wind turbine owners and project developers. This means that there both should be a reasonable rate of return and enough financial stability in the incentives for investors to ensure a feasible payback time [14, 15]. Secondly, wind power projects should contribute to *local/regional economy and development dynamics*. In economic terms this could simply mean a fair distribution between the costs and benefits associated with wind power projects. Due to the distributed character of wind turbines it is thus necessary to ensure the support of local citizens for wind turbines in their neighbourhood. Such a fair benefit distribution can be created through several measures including community ownership and other ways of actively involving the local community. Obviously, the first condition is a prerequisite for the second: the overall financial incentive structure should encourage the willingness of local communities to invest in wind turbines. Having a good economic basis and a local community of investors is however not sufficient, if the implementation is delayed, prevented or complicated otherwise by the admission procedures in place. The third set of factors, establishing an efficient system of *public administration and planning procedures*, therefore needs to be set up in a way that supports the administrative handling of wind power projects. In practice this means that local authorities need to have the necessary tools and incentives to forward the admission process, while at the same time balancing all interests involved. The connection to the second set of factors appears when considering that with the “right” planning system in place, local authorities can support wind power and thus create local development. Finally and probably most importantly, the three sets of factors need to be embedded within the framework of *energy* policy *and public planning policy*. Here it is important to stress that a concrete national energy policy that sets long term development goals for renewable energy can be a crucial driving force. Apart from that there needs to be coherence and flexibility between the two policy domains, so that changes in the energy policy take into account effects and requirements related to the planning system and vice versa.

1.2 Structure of the paper

In this paper we examine the recent developments within the Danish political and planning framework to support wind power development. Figure 1 forms the starting point for this

examination, whose main goal it is to understand to what extent the system, consisting of the three elements described above, has been established and is working in the Danish context. We apply the abovementioned macro perspective to divide the analysis into two parts: section 2, where we describe the existing financial incentive structure as well as its provisions and relations to local and regional economy and development; and section 3, where we describe the formal planning process for wind power in Denmark. In section 4 we focus more deeply on "the third sphere": the public administration and planning process. We use the case of wind power sites in the region of Northern Jutland to illustrate and discuss the structure of the wind power planning procedures in practice. Section 5 then is a synthesis where we discuss the interplay of the elements in the macro perspective and point out a number of issues that are crucial in supporting this interplay.

2. FINANCIAL INCENTIVE STRUCTURE: THE POLITICAL FRAMEWORK FOR WIND POWER IN DENMARK

The following sections contain a description of the political framework that forms both the basis for the financial support scheme for wind power in Denmark, and by a number of provisions establishes clear links to the set of factors that we label local and regional development dynamics. These two sets of factors are thus described together here.

2.1 New legislation

After several years with a distinct increase in wind power capacity in the 1980's and 1990's, which was conditioned by a favourable national policy including long term development goals and feed-in tariffs, financial support for wind power was cut back between 2001 and 2007. The resulting stagnation in wind power development and even a slight decrease in total capacity in 2007 (DEA 2008) underlined the relation between an appropriate economic incentive system and the development of renewable energy technologies[2].

In 2008 two political documents signalised comparably fundamental changes in Danish energy policy: the *Energy Agreement* [16] and the *Law on Renewable Energy* [17]. In February 2008 the Danish government together with the remaining parties of the parliament published the Energy Agreement (EA). The agreement covers the period between 2008 and 2011 and forms the basis for new energy-related legislation during that period. The main objectives in the EA are to reduce Denmark's dependency on fossil fuels and to reach a renewable energy share of 20% in gross energy consumption in 2011. The EA provides for measures to fulfil these goals within the areas of: energy savings and efficiency, renewable energy, energy taxes, new and more efficient energy technologies, and transport. Regarding renewable energy the EA includes the drafting of a Renewable Energy Law (REL) to come into force in the beginning of 2009. The REL was passed in the end of December 2008. The intention with the REL is to gather all renewable energy legislation in one legal document. The REL has changed the financial incentive structure for wind power in particular and through certain new provisions has direct implications for the implementation at the local level. This is illustrated in the following sections.

[2]According to the national register for wind turbines, as of January 2009, the total new capacity installed between 2004 and 2007 amounted to around 47 MW, compared to around 78 MW installed in 2008 ('Master data register for wind turbines at end of January 2009', Danish Energy Agency 2009). The period of 2004-2007 can be chosen to compare the effect of the reduction of subsidies, because although subsidies were cut down already in 2002, the period between 2001 and 2003 was effected by the previous repowering scheme for wind turbines (see section 2.3) and the long planned installation of offshore wind farms, which were implemented regardless of the political changes at that time. Thus, according to the national register between 2001 and 2003 alone, around 847 MW of new capacity were installed.

To begin with, it should be mentioned that financial payment to wind turbine owners in Denmark consists of two main components: a fluctuating market price for electricity and a price subsidy. While the former to a large extent depends on market economic conditions, the latter is more subject to national political control. The economics of wind power can thus partially be steered by national energy policy.

2.2 Financial support scheme for wind turbines onshore

As part of the new legislation the financial support for wind power in Denmark was improved. The current tariff structure for new and existing turbines is illustrated in Table 1, where the tariff scheme for existing turbines was only modified slightly in the new legislation. In general the tariff for new turbines has improved in two ways: i) the fixed payment per kWh has not only more than doubled, compared to turbines installed between 2002 and 2008; ii) but also the fixed maximum sum of market price and subsidy has been removed[3].

Table 1. Overview of the current subsidy scheme for new and existing turbines not using scrapping certificates, according to the provisions in the REL. The provisions for turbines installed before February 21, 2008 were adopted from the existing legislation. Thus, the subsidy conditions for already installed turbines remain the same.

Grid connection	Type of subsidy	Subsidy Period
after Feb. 20, 2008	0.03 €/kWh + 0.003 €/kWh + 0.005 €/kWh (incl. balancing costs and green fund)	first 22,000 peak load hours
between Jan. 1, 2005 and Feb. 20, 2008	0.013 €/kWh	20 years
between Dec. 31, 2002 and Jan. 1, 2005	0.013 €/kWh + 0.003 €/kWh (incl. balancing costs; fixed maximum sum of market price and subsidy: 0.048 €/kWh)	20 years
before Dec. 31, 2002	fixed maximum sum of market price and subsidy: 0.08 €/kWh	10 years (until Dec. 31, 2012 at the latest) during 25,000 peak load hours for turbines below 201 kW during 15,000 peak load hours for turbines below 600 kW during 12,000 peak load hours for turbines above 600 kW

An additional tariff structure applies to *wind turbines installed by energy utilities* (§40). Onshore wind turbines receive a subsidy of 0.01 €/kWh and together with the electricity price it may not exceed 0.04 €/kWh. The subsidy applies to wind turbines connected to the grid after January 1, 2000 and is given during 10 years. According to the REL (§41) so called *domestic*[4] wind turbines with an installed capacity of no more than 25 kW are granted a cumulative tariff (subsidy + market price) of maximum 0.08 €/kWh, regardless of the date of grid connection.

[3]For turbines connected to the grid before December 31, 2002 the fixed maximum sum of the subsidy and the market price is set to not exceed 0.08 €/kWh. Sum of subsidy and market price may not exceed 0.06 €/kWh if the specified amount of electricity (peak load hours) has been produced before the 10 years, and vice versa the subsidy is set to 0.04 €/kWh (the total sum may still not exceed 0.08 €/kWh). In any case the subsidy is only given until December 31, 2012.

[4]Domestic wind turbines only produce for household electricity consumption and are not connected to the grid.

2.3 Wind turbine repowering

The long term goal for wind turbine development in Denmark is to reach a larger installed capacity with comparably fewer numbers of turbines. For this reason the smallest turbines have to continually be replaced by larger ones. Denmark has introduced repowering schemes since 1994 and between 2000 and 2003 this was for the first time combined with a feed-in tariff for installation of new turbines. As result of this scheme the total number of wind turbines was reduced by 1,208, while at the same time yielding a capacity increase of 202 MW [18]. In 2004 the Danish government agreed on a new repowering scheme for wind turbines with a capacity of 450 kW and below. The scheme has entered the new legislation and covers a grid connection period January 1, 2005 until December 31, 2010, where turbine owners can receive an extra subsidy if using a scrapping certificate for turbines dismantled between December 15, 2004 and December 15, 2010. The original goal of the scheme from 2004 – to replace 175 MW of existing capacity with 350 MW of new capacity – was left unchanged in the new legislation. When using scrapping certificates turbine owners therefore should install new wind turbines having the double of the capacity of the dismantled turbine(s). The tariff conditions for the new repowering scheme are summarised in Table 2.

Table 2. Overview of the current scheme for extra subsidies for new and existing turbines using scrapping certificates. Subsidies are given in addition to the subsidies shown in Table 1 on the basis of certificates for decommissioned turbines. The provisions for turbines installed before February 21, 2008 were adopted from the existing legislation. Thus, the subsidy conditions for already installed turbines remain the same.

Grid connection	Type of extra subsidy	Subsidy Period
Feb. 21, 2008 - Dec. 31, 2010	choice between: a) 0.01 €/kWh extra subsidy b) 0.016 €/kWh (fixed maximum sum of market price, subsidy and extra subsidy: 0.05 €/kWh)	during 12,000 peak load hours for the double of the effect of the dismantled turbine
between Jan. 1, 2005 and Feb. 20, 2008	0.016 €/kWh (fixed maximum sum of market price, subsidy and extra subsidy: 0.06 €/kWh)	during 12,000 peak load hours for the double of the effect of the dismantled turbine
between Apr. 1, 2001 and Jan. 1, 2004	0.02 €/kWh	during 12,000 peak load hours

Under to the current repowering scheme owners of new turbines can choose between the tariff of the original scheme from 2004 or a fixed supplement, which is given together with the new subsidy regardless of the market price. In this way new turbine owners can choose to receive a stable subsidy, both with and without using scrapping certificates. Unless the market price of electricity will decrease below around 0.04 €/kWh for a longer period, this will provide a rather stable economic basis for turbine developers. This issue is further discussed in the following section.

2.4 Project-economic effects of the new subsidies

To evaluate the effects of the new subsidy scheme of 2008 on the economy of individual wind turbine projects, concrete budgets were estimated, comparing the effects of the previous (2005-2008) and the new subsidy scheme on a project's economy. Calculations for two wind turbine examples have been made: a medium-sized, 2 MW turbine with a total height of around 126 m; and

a smaller, 850 kW[5] turbine with a total height of around 75 m[6]. For both cases 4 calculations have been made using the subsidy figures from Table 1 and Table 2: i) applying the new subsidy scheme; ii) applying the old subsidy scheme; iii) applying the new subsidy scheme and repowering scheme; and iv) applying the old subsidy scheme and repowering scheme. An electricity price of 0.04 €/kWh was used in the first two examples, which was estimated to be around the average on the Nordpool spot market for Western Denmark in the beginning of 2009[7]. A historic average price for the year 2006 of 0.044 €/kWh was used in the two latter examples to estimate how the project economics would have been under the old subsidy scheme[8]. The fixed maximum sum of market price and subsidy of 0.06 €/kWh was furthermore chosen to be applicable for the examples calculated under the old subsidy scheme. Under the new repowering scheme turbine owners have the choice between a maximum market price-subsidy sum of 0.05 €/kWh and a fixed subsidy of 0.01 €/kWh. The fixed subsidy was chosen in the examples that fall under the new repowering scheme.[9] The interest rate was set to 6% in all examples, turbine life time to 20 years, inflation on the market price to 2% and the expected annual production was assumed to be 6.000.000 kWh for the 2 MW turbine and 2.100.000 kWh for the 850 kW turbine, which corresponds to a favourable onshore location. Finally, a maximum utilisation of scrapping certificates (i.e. equal to the new turbine's capacity) was assumed, both under new and old repowering scheme. The results of the calculations in terms of investment payback time are shown in Table 3.

Table 3. Comparison of payback times for two kinds of wind turbines under the old and new subsidy scheme, and both with and without falling under the repowering scheme using scrapping certificates. The calculations account for the subsidies presented in Tables 1 and 2.

[5]850 kW turbines are the only "non-domestic" (i.e. 25 m) turbines currently available on the Danish market, which at the same time have a total height below 80 m (compare section 3 regarding rules for Environmental Impact Assessment). They are produced by only one of the two approved manufacturers in Denmark.

[6]The examples are based on figures and budget calculations provided by project developers Gert Kristensen and Kaj Holm, both GK Energi ApS.

[7]According to Energinet.dk's market reports for the first three months of 2009 the average system price for Western Denmark was around 0.038 €/kWh. (Retrieved 29 April, 2009 from: http://www.energinet.dk/da/menu/Marked/Om+elmarkedet/Markedsrapporter/Markedsrapporter.htm)

[8]The historic market price was averaged for the 12 months of 2006 as retrieved on April 29, 2009 from: http://www.energinet.dk/da/menu/Marked/Om+elmarkedet/Markedsrapporter/Markedsrapporter++fra+2006/Markedsrapporter+fra+2006.htm). The year 2006 was chosen because prices in 2007 were comparably low.

[9]With the assumed market price of 0.04 €/kWh there is not a big difference in choosing the fixed subsidy of 0.01 €/kWh or the maximum sum of market price and subsidy of 0.05 €/kWh.

Susbsidy scheme	Wind turbine + annual production	Electricity Price + subsidy	Payback time
New (2008-)	i) 2 MW, 6000 MWh/year	0.04 €/kWh + 0.03€/kWh	15.3 years
	ii) 850 kW, 2100 MWh/year	0.04 €/kWh + 0.03€/kWh	16.3 years
Old (2005-2008)	iii) 2 MW, 6000 MWh/year	0.044 €/kWh + 0.013 €/kWh	15.3 years
	iv) 850 kW, 2100 MWh/year	0.044 €/kWh + 0.013 €/kWh	17.8 years
Incl. Repowering			
New (2008-)	iii) 2 MW, 6000 MWh/year, scrapping certificates for 2 MW	0.04 €/kWh + 0.03€/kWh + 0.01 €/kWh	13.2 years
	iv) 850 kW, 2100 MWh/year, scrapping certificates for 850 kW	0.04 €/kWh + 0.03€/kWh + 0.01 €/kWh	13.1 years
Old (2005-2008)	iii) 2 MW, 6000 MWh/year, scrapping certificates for 2 MW	0.044 €/kWh + 0.013 €/kWh + 0.007	14.4 years
	iv) 850 kW, 2100 MWh/year, scrapping certificates for 850 kW	0.044 €/kWh + 0.013 €/kWh + 0.007	15.3 years

The results indicate that the payback times for wind turbines under the old subsidy scheme in general are longer, with the exception of the 2 MW turbine, where the payback times are the same according to the new and old legislation, not using scrapping certificates. Apart from that, payback times under the old scheme are longer, although somewhat optimal conditions with regard to the market price were assumed. The payback times under the new repowering scheme are the most favourable – those payback times are in fact the only two that could be considered feasible in terms of project financing through bank loans etc.. Together with the new repowering scheme, the new legislation seems to add most to the feasibility of smaller turbines, where theoretically an improvement in the payback time from 17.8 years to 13.1 years can be achieved. It can also be seen that although the new subsidy scheme in general has improved the economy of wind power projects, the currently low market prices for electricity add a considerable element of uncertainty to project financing, unless scrapping certificates can be used. With a turbine life time of 20 years a payback time of 15 to 16 years must be considered rather risky. Obviously, the assumptions made for the new turbines are rather "careful" and market prices are likely to increase after the economic recession. There are furthermore other factors that have an influence on the feasibility of wind power projects, such as the investment costs and location of the wind turbine. Nevertheless it can be concluded that the new subsidy scheme has not contributed as significantly to the feasibility of wind power projects as perhaps expected in 2008, when the legislation was made and market prices for electricity were higher. Instead of a "fixed maximum price-subsidy sum" it could therefore be discussed to what extent the introduction of a "fixed minimum sum" of electricity price and subsidy should be considered that can guarantee an average feasible payback time, of for instance 13 years[10].

Apart from this project-specific evaluation of wind power economics it is important to note the national effects that wind power has from a socio-economic point of view. Investigating the overall socio-economic costs and benefits of wind power could form the basis for the comparison of

[10] Another characteristic of the new legislation is the introduction of the peak load hour cap of 22,000 hours (see Table 1), which means that subsidies are no longer paid after the peak load hours have been "consumed", which in the example of the 2 MW turbine is after 7 years and after 9 years for the 850 kW turbine. This means that after this period turbines will solely produce under market conditions.

different energy technologies and their socio-economic costs. Among others, such a calculation would have to include employment effects, environmental costs and the impact on foreign exports. This lies beyond the scope of this paper, and it is in this context simply assumed that wind power is a politically and economically accepted, feasible and beneficial technology to be included in future energy plans. A few notes on the socio-economic costs of wind power in Denmark may however be illustrative. Previous studies have for instance concluded that when comparing national wind power expenses to employment and export effects of wind power, the Danish state actually makes an income (see [29] for example). Nowadays, on a liberalised Nordic electricity market it is more difficult to draw conclusions on the total costs of wind power expansion. Electricity produced from wind power is during an increasing amount of hours the marginal electricity source on the Nordpool market, resulting in a decrease of the overall electricity price. The costs saved due to this effect do in our understanding approximately match the total subsidies wind power receives. Apart from that, export from Danish wind power companies has outgrown the income from the domestic market by far, and Vestas, the largest domestic manufacturer, has a stock exchange value of around 20 billion €. Looking at the last 30 years of wind power development it seems to be obvious that wind power has given the Danish state a rather substantial net income.

2.5 New elements in the current legislation

Besides a stable economic support, local entrepreneurship and cooperative ownership of wind turbines were some of the main success factors for Danish wind power development [19, 15]. These factors were crucial in securing public support and acceptance and helped wind power to become a “popular” technology. The significance of such factors is highlighted by the implementation failures and siting problems due to public protests experienced in other countries [20, 21]. Seen in combination with continuously increasing turbine sizes there therefore is a need to ensure public acceptance and local involvement with regard to wind power. Towards the end of the 1990’s however the local engagement in wind power development in Denmark began to vanish, when due to increasing turbine and farm sizes higher project budgets were required and therefore larger, “national” actors got involved. Due to the increasing costs, local co-ownership therefore became hard to ensure. According to the new Danish legislation it is the aim to respond to the issues by means of four new provisions: an option for local citizens to purchase turbine shares; a guarantee fund for wind cooperatives; a green order to support local acceptance; and a compensation scheme. The new provisions are described in the two following sections.

The first of the four new provisions concerns the *option to purchase shares* to support local cooperative wind turbine ownership, which came as part of the EA and was implemented in the REL (§13-§17). According to this rule local citizens shall be offered the possibility to buy shares in turbines higher than 25m to be erected in their neighbourhood. More specifically, the project developer shall, prior to the installation, tender at least 20% of the shares to people who live within 4.5 km of the site. Apart from that anyone living in the municipality where the turbine(s) are to be installed can apply to buy shares. Priority shall however be given to the first group of people. The project developer shall in relation to the tender process prepare information about the project, and it is the task of the TSO (Energinet.dk) to approve of the tender process and the information material used therein. The Ministry of Climate and Energy has the possibility to change the tender model and the requirements regarding the tender material.

Following the EA and the REL (§21) the establishment of local cooperative ownership of wind turbines shall be supported by means of a *guarantee fund*. The total budget of the fund is around 1.3 million € and it is financed through Public Service Obligations (PSO) by the system operator and

the transmission companies. In applying to the fund, local cooperatives consisting of at least 10 members living within 4.5 km of the planned wind turbine site can get financial support of up to around 66,000 € to conduct preliminary studies. The guarantee fund applies to both turbines onshore and offshore. The challenge of local acceptance in (onshore) wind turbine planning is recognized in the EA and the establishment of a green fund, which can support initiatives to increase local acceptance of wind turbines, is intended. In the REL (§18) this is replaced by a *green order*, which entails the subsidy of 0.005 €/kWh during the first 22,000 peak load hours to be paid by the system operator Energinet.dk. This subsidy is collected by TSO in the form of a "green municipal wind account". The green order is established by the Ministry of Climate and Energy and the subsidy is credited to municipalities in which the new turbines are installed. Municipal authorities can in relation to the green order apply to Energinet.dk for funding of projects that increase landscape and recreational value or local activities to increase acceptance of renewable energy technologies. This funding is then subtracted from the municipality's green wind account.

Part of the resistance to wind power in Denmark is due to the loss in real property value, caused by onshore wind turbines. Therefore, as outlined in the EA and implemented in the REL (§6 - §12), loss in real property value is to be compensated for by the project developer. The *compensation scheme* is rather elaborate and its main points are listed here.

- The loss in value is either specified by an assessment authority (taksationsmyndighed) consisting of chairman (lawyer) and a real estate agent; or the owner of the real property and the turbine owner/developer can agree on the amount of the compensation
- For both wind turbines requiring an environmental impact assessment (EIA) and for those that do not, turbine owner/developer is to hold a public meeting early in the planning process informing about the local consequences of the turbines (§9)
- Energinet.dk plays a central role with regard to approval of information material and invitation sent out prior to the meeting; and in general concerning information and consultation
- Property owners have to report compensation claims to Energinet.dk shortly after the public meeting
- Property owners do not have to pay for handling their cases if their estate is located at least within a distance 6 times the height of the wind turbine(s); others have to pay about 530 € to Energinet.dk, which will be refunded in case of payment of compensation
- The turbine owner/developer has to cover the legal costs in case compensation is granted (§11)

3. PUBLIC ADMINISTRATION AND PLANNING PROCEDURES: THE PLANNING PROCESS FOR WIND POWER IN DENMARK

The following sections serve to illustrate the formal set up of box 3 of the macro perspective – public administration and planning for wind power in Denmark. This set up is illustrated in Figure 3 together with box 1 and box 2 that are described for the Danish case in the previous sections. As indicated previously, since the reform of local governments in 2007 the planning of wind turbines is to a large degree the task of the municipalities. Therefore box 3 is discussed mainly from a municipal planning point of view.

3.1 Overview of tasks in municipal wind power planning

When it comes to planning and administration, wind turbines are treated similar to other types of technical infrastructure in Danish planning law. They are thus subject to a similar planning process, including the process of issuing municipal plan guidelines, a local plan[11] and building permit for the respective wind turbine site and decisions regarding the assessment of environmental impacts. Apart from that, the local government reform gave Danish municipalities the possibility to point out future locations for wind turbines in the new Municipal Plans[12]. Figure 2 shows the main tasks in wind turbine planning, which also involve the municipalities. The Ministry of Environment is, except from the Renewable Energy Law, responsible for administrating the legal basis and corresponding guidance for the planning work of the municipalities. As regards finding appropriate wind turbine sites the wind turbine circular is a key document[13]. The main principle of the circular is that wind turbines can only be built in specific areas that have been pointed out in the municipal plans. The latest version of the circular dates back to 1999 and contained guidelines for wind turbine siting in the former counties. After the local government reform in 2007 a new corresponding document was required that could support siting of turbines in the new municipalities. In the beginning of 2009 only a draft version of the new circular was available, which in line with the REL contains specifications as to how wind turbines shall be sited in and by the municipalities. According to those specifications wind turbines should preferably be placed in appropriate patterns of groups, keeping a distance to neighbour buildings of at least 4 times the total turbine height and 4.5 km to other existing or planned turbines. The maximum height of wind turbines is set to 150 m and so called domestic turbines up until a height of 25 m are excluded form those provisions.

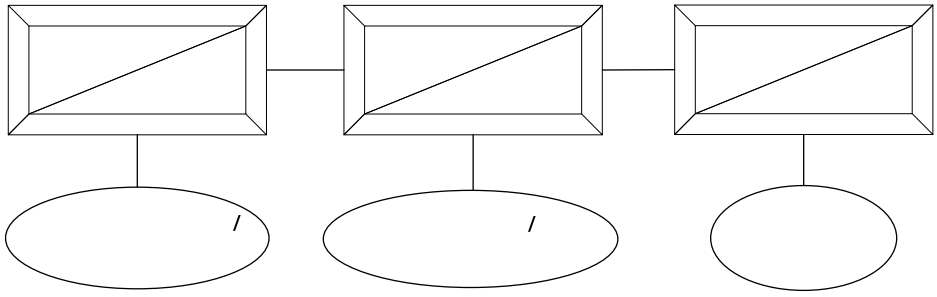

Figure 2. Main municipal tasks in wind power planning and their legal basis. Through the local planning process municipalities have the possibility to point out a number of wind turbine sites for project developers to apply for. For larger turbines and groups of turbines an EIA has to be carried out (by the developer), which results in specific guidelines for turbine design and installation in the municipal plan, and finally a local plan for the respective wind turbine site.

Rules regarding Environmental Impact Assessment (EIA) of wind turbines are specified in the Planning Act (§11g) and in an Executive Order regarding EIA of certain facilities [22, §3, Appendix 1, 37.]. Wind turbines can only be built after the municipal council has prepared municipal plan guidelines that describe the turbines' location and design. These guidelines have to be accompanied

[11]A local plan (in Danish: lokalplan) can be understood as a district plan.

[12]Prior to the reform wind turbine siting was the task of the counties. According to the Danish Planning Act the Municipal Plan forms the comprehensive basis for the development in a municipality. It covers a period of 12 years and contains the main objectives and guidelines regarding land use as well the scope for the content of local plans in the various parts of the municipality (LBK nr 1027 af 20/10/2008, §11). In 2009 a number of municipalities are completing their work with the municipal plans, which was initiated in relation to the local government reform in 2007.

[13]In Danish: 'Cirkulære om planlægning for og landzonetilladelse til opstilling af vindmøller', draft version of February 26, 2009

by an Environmental Impact Statement (EIS), which is typically prepared together with the project developer and/or a consultant [23]. These rules regarding EIA apply in particular to wind turbines higher than 80 m or groups of wind turbines with more than 3 wind turbines (EIA Executive Order, Appendix 1, 37.). Together with a draft for the local plan, proposals for the municipal plan guidelines and the EIS can then simultaneously be sent into public hearing before entering the political reading process [23]. For small (groups of) wind turbines, having a capacity 25kW and a total height until 80m, an EIA only needs to be carried out in case the municipal council expects significant environmental impacts from the wind turbines [22, §3, Appendix 2, 3i]. Otherwise, drafting a local plan including the usual public hearing process (see Figure 4) is sufficient for these kinds of wind turbine projects.

3.2 Four-year wind power agreement with municipalities

To keep track of the implementation of the repowering scheme the former Ministry of Economic and Business Affairs and the Ministry of the Environment had in 2004 initiated a monitoring process for the planning progress in the former counties and since 2006 in the municipalities[14]. The progress report of December 2007[15] showed that out of the 350 MW that should be installed according to the repowering scheme local plans for only about 100 MW had been finalised[16]. This may be the reason why the period of applicability of the repowering scheme was extended by one year until 2010 in the new legislation (see also section 2.3). In addition to that the Danish government and Local Government Denmark have entered an agreement in April 2008, which obliged the municipalities to have provided the planning basis for the remaining MW wind power under the repowering scheme by the end of 2008[17]. In December 2008, another progress report[18] showed that in spite of this agreement and the fact that the municipalities had expected to have provided the planning basis for a total wind power capacity of around 330 MW[19], local plans for only around 220 MW had been finalised. The possible reasons for this delay are further discussed in

[14]Økonomi- og Erhvervsministeriet (2004): 'Placering af landbaserede vindmøller', 29. april, 2004. ('Siting of onshore wind turbines'). In this and another letter from 2005 the ministries encourage the counties to cooperate with the municipalities in relation to pointing out wind turbine sites in the county plans to ensure the implementation of the repowering scheme. The letter also refers to the first version of the wind turbine circular of 1999. From the beginning of 2005 and onwards the regional/municipal planning progress was reported every couple of months in terms of MW capacity that is being planned for.

[15]Miljøministeriet (2007): 'Status for december 2007 for kommunernes tilvejebringelse af plangrundlaget for vindmøller til gennemførelse af udskiftningsordningen', 21. december 2007. ('Progress report for December 2007 on the provision of the planning basis for wind turbines in the municipalities for the implementation of the repowering scheme')

[16]It should be noted that an existing local plan can be appealed against in the Board of Nature Complaints (Naturklagenævnet) and that therefore turbine installation cannot necessarily commence at the time the local plan is published. See also section 4.

[17]'Aftale mellem regeringen og KL vedrørende udbygning af vindmøller på land for perioden 2008 – 2011 begge år inkl.' ('Agreement between the Government and LGDK regarding the installation of onshore wind turbines for the period of 2008 – 2011 including both years') (Retrieved April 21, 2009 from: http://www.kl.dk/_bin/99b778c2-df82-4a81-a633-5e5ae7d0cea6.pdf)

[18]Miljøministeriet (2009): 'Status pr. 31. december 2008 for kommunernes tilvejebringelse af plangrundlaget for vindmøller til gennemførelse af udskiftningsordningen', 22. januar 2009. ('Progress report as of 31 December 2008 on the provision of the planning basis for wind turbines in the municipalities for the implementation of the repowering scheme')

[19]Miljøministeriet (2007): 'Status for december 2007 for kommunernes tilvejebringelse af plangrundlaget for vindmøller til gennemførelse af udskiftningsordningen', 21. december 2007. ('Progress report for December 2007 on the provision of the planning basis for wind turbines in the municipalities for the implementation of the repowering scheme')

section 4, but at this point it may be worth noting that the final version of the second wind turbine circular, which seems to be crucial for defining specific planning guidelines in the municipal and local plans, still was not in effect in the beginning of 2009. This seems especially problematic when comparing the 1999 version of the circular to the main (proposed changes) in the early 2009 version of the draft[20], where i) the formal responsibility for reserving wind turbine sites is handed over from the former counties to the municipalities; ii) the 150 m height limit for wind turbines is introduced; and iii) the minimum distance to neighbouring wind turbines is raised from 2.5 to 4.5 km. Regardless of any potential obstacles posed by official siting guidelines or during the local planning process, municipalities seem to have shown some interest in reserving wind power areas. In the same status report of December 2008 it is mentioned that municipalities have suggested a total amount of 900 MW (400-450 wind turbines) to be planned for[21]. This indicates a mismatch between the wind power sites that seem appropriate in municipal planning and the sites that actually are approved after the official and public planning and administration procedures have been fulfilled.

The wind power agreement between the government and LGDK also obliges the municipalities to provide the planning basis for 75 MW wind power capacity in both 2010 and 2011, i.e. in total for 150 MW[22]. The Municipal Contact Councils (MCCs)[23] play an important role in implementing this provision, as they are responsible for dividing the municipalities into groups that should fulfil a certain share of the overall objective. Finally, any municipal objective under the repowering scheme, exceeding the total amount of 350 MW, will automatically count as contribution to the 2010 and 2011 objectives.

3.3 The Wind Turbine Secretariat

In line with the structural reform the Ministry of the Environment has established 7 regional Environment Centres that have taken over a number of tasks previously managed by the regions. In order to support the municipalities in wind power planning the Ministry has furthermore set up the Wind Turbine Secretariat, which is associated to 3 of those Environment Centres. The Secretariat was established in the end of 2008 as part of the agreement with the municipalities to provide a planning basis for wind turbines until 2011. The initial intention is that the Secretariat is in operation during 2 years and its main task is to support municipalities in wind turbine planning. For this the Secretariat offers assistance regarding, for instance, finding sites that are most suitable in relation to the interests of neighbours and nature protection. It also offers exchange of experiences between the municipalities and by the beginning of 2009 already 49 out of 98 Danish municipalities had contacted the secretariat[24].

After having separately discussed the three boxes of the macro perspective introduced in Figure 1 in the concrete Danish context, a “system view” for wind power development in Denmark can be drawn, as illustrated in Figure 3. In this “actor-task-representation” the context of energy and

[20]Miljø- og Energiministeriet (1999) ‘Cirkulære om planlægning for og landzonetilladelse til opstilling af vindmøller, Cirk. nr. 100 af 10. juni 1999

[21]Miljøministeriet (2009): ‘Status pr. 31. december 2008 for kommunernes tilvejebringelse af plangrundlaget for vindmøller til gennemførelse af udskiftningsordningen’, 22. januar 2009. (’Progress report as of 31 December 2008 on the provision of the planning basis for wind turbines in the municipalities for the implementation of the repowering scheme’)

[22]According to the agreement the municipalities have fulfilled their task as soon as the corresponding sites have been reserved in the form of guidelines for municipal plans and municipal plan amendments.

[23]The Municipal Contact Councils (Kommune Kontakt Rådene) are organisations in each of the 5 Danish regions that among others represent municipal interests when dealing with the Regional Councils.

[24]Telephone conversation with Kåre Albrechtsen, head of Wind Turbine Secretariat, January 30, 2009.

planning policy is merged into the three boxes in the form of “elliptical” tasks. Boxes 1 and 2 are linked directly through for instance the 150 MW agreement between the government and LGDK. One principal characteristic of this representation is however the configuration of box 3, which functions as a link between box 1 and box 2. This is illustrated by the four new elements in box 3 that on the one hand are elements of the new Danish energy policy (box 1) and on the other, are meant to “ease” the planning process associated with box 2. The TSO Energinet.dk for instance is as a public company linked to box 3, because it administrates the four new elements. The TSO is therefore directly related to the local effects of wind turbine development. Although the municipalities now are crucial actors in wind power planning, they are illustrated here as mainly belonging to box 2. Depending however on how big of an incentive the green order will turn out to be, municipalities may be willing to support or even invest in wind turbines, as this will give them access to payments from the green order.

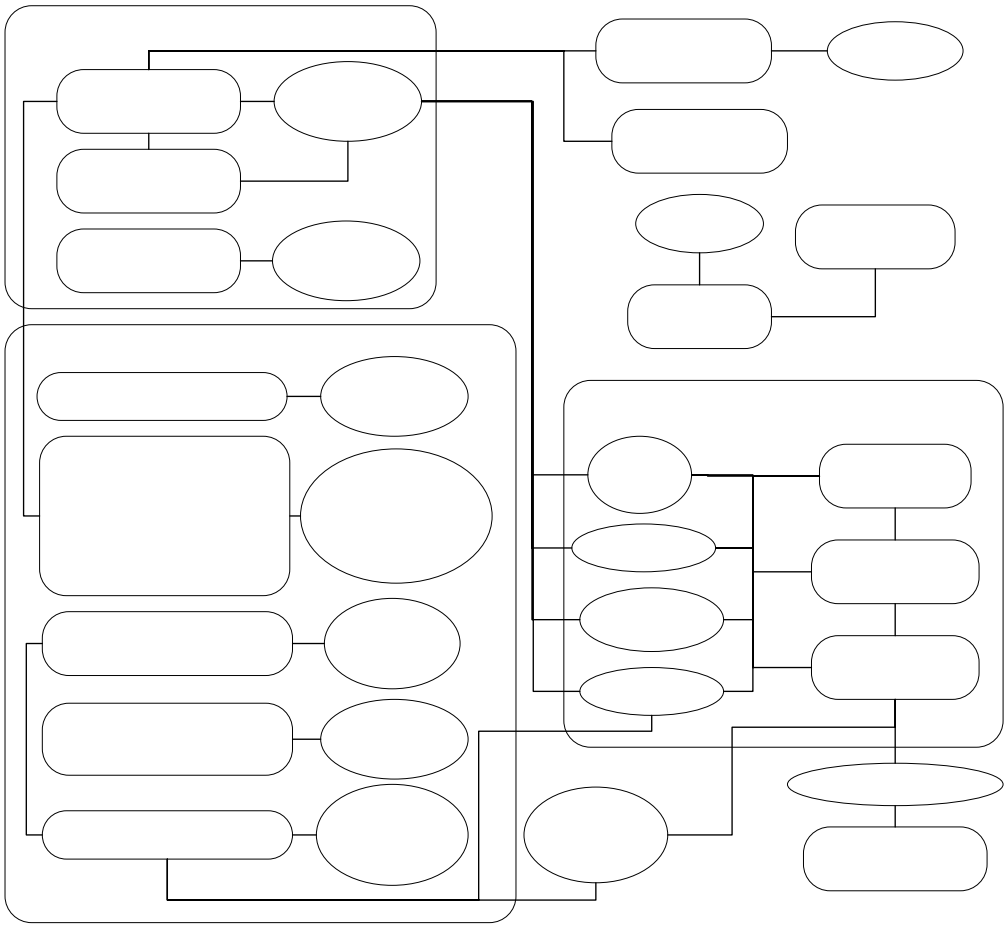

Figure 3. Distribution of actors and tasks in Danish wind power planning according to the three elements of the macro perspective. The figure is one way of representing the Danish system established around wind power, according to the macro perspective introduced in Figure 1. One main characteristic of this representation is that the context of energy and planning policy is merged into the three boxes as represented by “elliptical” tasks. Tasks and actors related to turbine manufacturing and certification, as well as general information complement the macro perspective, although they are not further discussed in this paper.

4. WIND POWER PLANNING IN NORTHERN JUTLAND

After having described the three boxes of the macro perspective for the Danish case in general we will in this section investigate box 3 in more detail. By this we mean an understanding of how the planning of concrete wind power projects happens in practice. The input for this discussion is based on insights from 15 wind power projects in the Danish region of Northern Jutland. In doing so the section follows the objective of evaluating the planning process, both in terms of average time required and reasons for project delay. The results in this section are based on empirical findings obtained from wind power project developers, municipal planners and government officials. These persons were mainly contacted by telephone and email during February and March 2009. The frame of this paper does not allow for detailed project descriptions, but main findings are summarised were appropriate.

4.1 Potential wind power projects in Northern Jutland

As indicated in section 3, in 2004 the Ministry of the Environment had started a monitoring process to follow the implementation of the second repowering scheme for wind turbines. In this connection the counties were asked to report on the progress for pointing out wind power sites in relation to the drafting of the regional plans in 2005[25]. Thus, at the end of 2006, in relation to the structural reform the planning responsibility for those wind power sites went to the municipalities. It therefore became the task of the municipalities to continue with the planning of the sites that were pointed out in the regional plans in 2005 and through regional plan amendments during 2006. The description of the case of Northern Jutland takes its point of departure in the Ministry's progress report of April 2007[26] – the first one after the structural reform. This progress report is also used as it is the first report of that kind containing an overview of all the 51 potential wind power projects suggested by the former counties and new municipalities. The progress of these 51 projects is still reported until today (early 2009). Apart from the 51, new sites, for which municipal planning has commenced recently, are also accounted for in the progress reports. One such site is located in Northern Jutland and is included in the case study. The total "feasible" wind power potential suggested by the municipalities in Northern Jutland in 2007 thus amounts to around 183 MW distributed over 15 sites. This distribution is sketched in Figure 4. All potential projects are aimed at turbine capacities of around 2 MW and between 100 m and 150 m total height per turbine[27].

[25] The former county of Northern Jutland (not including Thisted, Morsø and parts of Mariagerfjord municipalities) took the repowering scheme literally and required "inappropriately installed" wind turbines on specific sites to be dismantled in relation to the installation of new turbines on the 9 sites it proposed in amendments to the regional plan in the end of 2006 [24].

[26] Miljøministeriet (2007): '51 potentielle vindmølleprojekter, status april 2007' (51 potential wind power projects, as of April 2007)

[27] Miljøministeriet (2007): '51 potentielle vindmølleprojekter, status april 2007' (51 potential wind power projects, as of April 2007)

Figure 4. Potential wind power projects, pointed out by the municipalities in the region of Northern Jutland (Nordjylland) as of 2007. The figures indicate total potential capacity per site – typically distributed over a few large wind turbines (2-3.6 MW) per site. One wind turbine symbol stands for one site in the respective municipalities. Four municipalities (Frederikshavn, Hjørring, Læsø and Mariagerfjord) have not pointed out any specific sites officially by early 2009.

4.2 Status of wind power projects in Northern Jutland as of early 2009

In table 4.1 the status of the 15 wind power projects is listed. It can be seen that the total number of potential wind power capacity is reduced to around 172 MW – mainly due to the reduction in overall turbine capacity in the 54 MW project. Around 20 MW (3 projects) have been installed to date and a further 67 MW (4 projects) are expected to be installed under the repowering scheme. However, for only 2 of those projects no major complaints to the local plans have been received, which means that the other 2 projects could still be delayed (see section 4.3 below). For 2 of the projects (around 26 MW) the municipal planning process had not been completed by the time of the study. Definite statements about these projects can therefore not be made. The remaining 60 MW (5 projects) are unlikely to be carried out in time under the repowering scheme. Considering the current financial situation (compare section 2.4) it is therefore uncertain when and if these 5 projects will be carried out. Altogether this means that only about 50% of the potential capacity might be utilised before the end of 2010, and that at least one third will not be installed by then.

Table 4. Planning status of the 15 wind power projects in Northern Jutland. It is distinguished between i) projects that have been carried out between 2005 and 2009 (“installed”); ii) projects for which a local plan has been approved and which are expected to be completed until 2010 under the repowering scheme; iii) projects that were in municipal planning at the time of the study; and iv) projects that are cancelled or delayed and therefore will not be part of the repowering scheme.

Status	Capacity (MW)
Installed	20.1
Expected installation until 2010	66.5
Municipal planning	25.8
Cancelled or delayed	59.5
Total	171.9

As Table 4 indicates, the planning process between 2005 and 2009 has in general resulted in different outcomes for the 15 wind power projects. While only a few projects have actually been implemented completely, a number of projects are delayed, downsized, moved to alternative locations or are (temporarily) given up. Following from the cases it is in other words not certain that a municipal plan and initiative of developing certain wind power sites will actually result in the installation of wind turbines.

The reasons for this mismatch between the anticipated plan and the actual outcome are complex and differ from one municipality to the other. A clear understanding for these reasons would require a further, more detailed investigation of the individual planning processes. Apart from that, a few tendencies that appear from the cases can be indicated:

- While some municipalities worked with the planning of individual sites, others initiated a longer term process of developing a wind power plan for the whole municipality. Such wind power plans would then often coincide with the overall preparation of the municipal plans, which will be finished by the end of 2009. This is partially why some municipalities decided to give up or postpone individual sites, for which public protests occurred (since they were making a more comprehensive plan anyway).
- Sites are given up due to public protests. In one project in the municipality of Thisted, for instance, tourists and surfers protested against wind turbines at one harbour site. Reacting to such kinds of protests is a political decision, and tourism is one major path of development for municipalities in Northern Jutland, and therefore also is a “good” reason to abandon wind power projects. In other cases “simple” neighbour complaints did not alter the final project.
- Sites are initially pointed out in a preliminary fashion. This means that specific guidelines for the site and turbines can only be developed after the formal procedures have been carried out, such as an EIA including sound measurements etc.. This can result in a reduction of the feasible capacity for the site. One site was given up due to the discovery of golden eagles, which shows that newly occuring nature protection interests can have a direct influence as well.
- Finally, a general tendency is that municipalities try to “gather” large turbines in groups and on as few sites as possible. This obviously complicates the planning process (per site), since more local impacts on the site have to be taken into account.

4.3 A timeline of the planning process for large onshore wind turbines

The insights from the previous sections and the case of Northern Jutland now allow us to suggest a timeline of which processes are and may be involved in (municipal) wind power planning in

practice. One suggestion for the set up of such a timeline is presented in Figure 5. The elements at the start of the timeline represented by dashed lines (municipal plan, municipal wind power plan) indicate the three ways wind power siting is carried out in the 15 projects: i) without new municipal plan directly on the basis of the existing regional plans; ii) through initiation of a more comprehensive process in relation to either the municipal plans or a wind power plan; and iii) through appointment of new, individual sites (in addition to the more comprehensive regional/municipal plans). It can in general not be determined how long the planning work of the authorities – i.e. the EIS discussion draft, municipal plan guidelines and the drafting of the local plan – could or should take internally. This is subject to the priorities and capacities of the municipalities and may therefore differ. But it is possible to distinguish a number of other factors that clearly have an influence on the duration of the planning process.

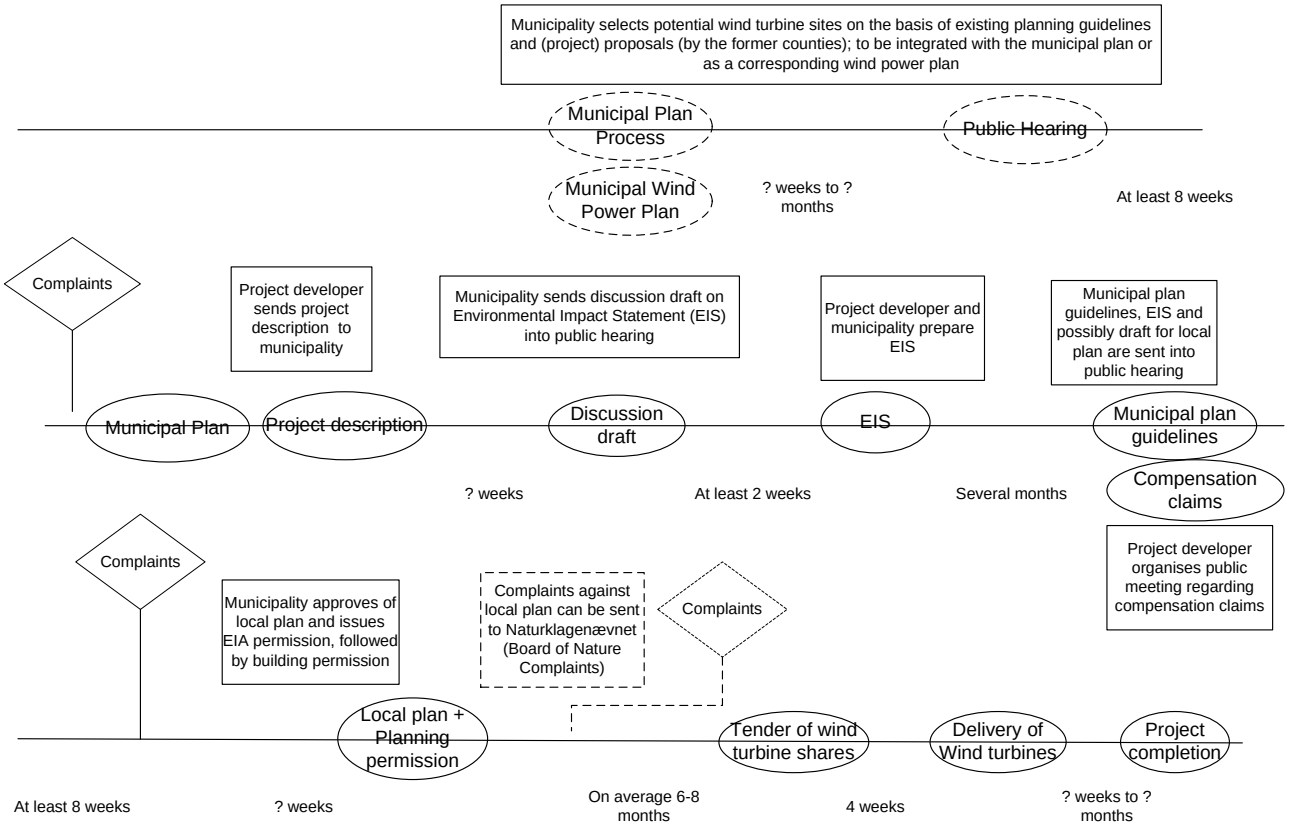

Figure 5. A timeline of the planning process for large wind turbines under the current conditions. The timeline is set up combining insights from sections 2.5 (new elements in the legislation) and section 3 (the formal planning process), and in particular from the case introduced in sections 4.1 and 4.2 above. Although there exist a number of formal procedures associated with specific timeframes (e.g. public hearings), there are a number of factors that are unpredictable and can stop or increase the duration of the planning process.

Firstly, having to prepare an EIA for large turbines adds considerably to the duration of the process. According to the insights from Northern Jutland, it can take between 6 to 12 months to finalise the EIS and municipal plan guidelines. Secondly, it is possible to send complaints to the municipality at different public hearings during the planning process: in relation to the municipal plan and in response to the draft of the local plan. All complaints need to be processed by the municipal authorities and the seriousness of complaints is finally decided by the council politicians. The local plan then can be appealed against by affected citizens. Depending on the quality of the complaint it

can on average take 6-8 months for the Board of Nature Complaints to process it.[28] Municipalities usually seem to expect an increase in the number of complaints in the later stages of the planning process, when the project becomes more concrete. As one municipal planner expresses it in relation to the planning process of one wind turbine site:

"It seems a bit strange that people start to protest now, after we have sent the draft of the local plan into public hearing. The same site has been part of the regional plan already, and we already had a public hearing phase in relation to the municipal plan guidelines, where they were announced in the local newspaper and presented at a couple of information meetings. Then we already started to receive complaints, but the highest number of complaints arrived in relation to the draft of the local plan. Although the law only requires us to send copies of the draft to the neighbours, we had sent it to the whole village." [Municipal planner #1][29]

The statement of the municipal planner not only indicates an increase in protests as projects get more concrete, but also highlights the role of public information and involvement in wind power planning (see also [25] and [26]). One could of course argue that there would have been fewer protests, if the municipality had not sent information directly to the citizens, but it seems to be more likely that the main reason for the high amount of protests is the relatively little amount of information required by law to be given to the public in the early stages of the planning process. This means that early involvement and building of trust, and possibly allowing citizens to introduce project proposals, may lead to a smoother planning process. Early engagement and information of the affected community may sometimes be even more crucial than financial benefits through community wind turbine shares, according to a statement made by another official:

"The project developer has tried to offer wind turbine shares in the neighbourhood, but some people did not want to have the wind turbines at all." [Municipal planner #2][30]

Furthermore, the delivery time for wind turbines is another factor that has an impact on the planning timeline. According to one project developer it may currently take around 1.5 years to get the turbines delivered. To expect the entire process from having an initial project proposal until the final delivery and installation of a large onshore turbine to take up to 3 years, therefore does not seem to be unrealistic.

In the future it will be relevant to investigate the influence of the new legal elements (compensation scheme and option to purchase shares) on the planning process. All sites, for which a local planning process had been initiated by early 2009, were exempted from these provisions.

4.4. Discussion

It becomes apparent from the case of Northern Jutland that municipalities are following the general trend towards larger onshore wind turbines concentrated on fewer sites. This trend has both advantages and disadvantages. Pointing out a few wind power sites gives municipalities the possibility to limit impacts from turbines to only a few places in the municipality, instead of for instance having single large turbines spread across the whole municipality. At the same time having to plan for a few sites only, and not for every single turbine, can potentially save administrative

[28]Certain complaints can be rejected immediately, if the party concerned is not entitled to appeal, for instance. Other complaints require processing of more than one year.
[29]Telephone conversation
[30]Telephone conversation

work in terms of for instance EIA, local planning and public hearings to be carried out. Carefully chosen and planned sites can therefore guarantee a limited amount of "disturbed" citizens and nature, while at the same time reaching municipal and national wind power goals. With a new version of the wind turbine circular underway and the support of the wind turbine secretariat there is also the possibility of selecting sites that fulfil the legally set distance requirements to neighbours. While all of this, together with the compensation scheme for neighbours and the share purchase option, can make wind power planning more "safe" for municipalities and developers, there still is no final guarantee that wind turbines will finally be installed on the few sites that are selected. This basically means that the fewer turbines and sites it is being planned for in a municipality, the higher also the risk of not getting wind turbines in the municipality at all.

The development also shows that municipalities approach the challenge of finding sites for large wind turbines and taking into account various interests and requirements with an "avoiding conflict strategy". It can be discussed to what extent this is due to the signals coming from the existing legislation, but it clearly entails an attitude of getting citizens' to accept a certain wind power development, instead of mobilising the (latent) support and engagement for wind power in the local community more actively. The draft of the wind turbine circular has been criticised in this regard, as it simply may leave municipalities with too little flexibility in their planning. Some interest groups have pointed out that the draft gives the impression that wind turbines *should* have a total height of more than 100 m and can only be placed in groups on sites suitable for large wind turbines, which are selected by the municipalities [27, 28]. If the draft would be adopted in its current version, it would possibly limit the engagement of local citizens in wind power and hinder a revival of community ownership [27]. The possibility of installing smaller (groups of) turbines across the entire municipality needs to be left open, in order to give local wind power initiatives the opportunity to install wind turbines within a reasonable distance to the respective residences [27][31]. In case of turbines below 80 m this could lead to overall faster processing in the authorities, if an EIA can be avoided (see section 3.1).

5. CONCLUSION

Wind power is expected to be a crucial ingredient on the way towards 100% renewable energy systems – not least in the case of Denmark. Onshore wind turbines will most likely continue to be an important part of this development, which already today results in a number of challenges. The size and capacity of turbines is increasing, leading to higher investment costs and making it increasingly difficult to find appropriate sites for turbine installation. This is mainly due to the greater local impacts that large wind turbines have, including higher visual and noise impacts to neighbours, and a higher amount of nature protection concerns to be taken into account. These challenges call for a wind power support system that integrates different policy and planning domains. A financial support system needs to be in place that can provide stable conditions for project developers. Furthermore, local planning authorities need to have the necessary means to further the siting and planning of wind turbines in the municipalities, and finally, a positive attitude towards wind power needs to be maintained in local communities by e.g. channelling the benefits of wind power to the local citizens. This paper introduces one suggestion for a more integrated system view, according to which wind power development is investigated both from a financial, planning and administration as well as local and regional development perspective. Thus we propose a macro perspective that can help evaluate energy and planning policy by examining their effects on the

[31] The trend towards fewer wind turbine sites increases the average distance between residences and turbines, which removes one incentive for local engagement in wind power, namely living close to the "fruits" of the work.

interplay between these three levels. The interplay and real life effects of policy on the three levels can in our view be best understood through the study of the concrete conditions for and the implementation of concrete wind power projects.

In this paper we show how one can begin to approach such integrated studies of the implementation context of wind power for the case of Denmark. Regarding the financial support system the results suggest that the subsidy scheme for wind power has in general been improved through a set of new legislation. This improvement may however not be sufficient in order to maintain wind power development (and "green growth" in general) in times of economic recession. The fluctuating market price for electricity adds an element of high uncertainty to the economics of wind power projects, and it could therefore be suggested to introduce a price guarantee for wind turbine, that can ensure at least a minimum feasible payback time for average wind locations. The new legislation also introduces a number of (fiscal) measures aimed at improving the local acceptance of wind power, and by this also seeks to create a link to the dynamics of local and regional development. While the positive attitude of (local) citizens towards wind power is crucial for a smooth planning process, the actual local development effects of the new legislation can at this point in time not be evaluated yet. However, when comparing the new legislation with the formal planning framework and an investigation of ongoing wind power projects in the Danish region of Northern Jutland, certain tendencies appear. Although the real life effects of the new legal elements aimed at improving wind power acceptance cannot be evaluated yet, it appears that they are aimed at large wind turbines of a 100 MW or higher – seen in combination with existing the planning guidelines. Operating according to some of those guidelines has so far resulted in rather long and complex planning processes in the municipalities of Northern Jutland. The overall status so far is that within a 5-year period probably only about 50% of the likely wind power potential will have been utilised. There therefore is a need for more flexibility in the current planning framework so that smaller wind turbines and faster planning processes are not excluded from the future development. If at the same time local wind power initiatives are given the possibility to agree on sites for (smaller) turbines, the probability of getting higher rates of local acceptance and thus a higher wind power penetration will be increased. Finally, there is the need for more long-term oriented objectives regarding wind power development, in line with other municipal planning that already covers time span of around 10 years. When municipalities need to be prepared to plan ahead until 2030 and beyond, it is not sufficient to go from 3-4 agreements, containing rather moderate quantitative goals. In this way a long term energy policy should be in line with a long term (municipal) planning policy.

ACKNOWLEDGEMENTS

The authors are grateful to Kaj Holm and Gert Kristensen for providing valuable information and insights. Apart from that we would also like to thank a number of respondents from governmental and municipal authorities as well as private organisations.

REFERENCES

1. Danish Government, *En visionær dansk energipolitik* (A visionary Danish Energy Policy), 2007. (Retrieved May 4, 2009 from: http://www.ens.dk/sw68153.asp)
2. Lund H, Mathiesen, B.V., Energy system analysis of 100% renewable energy systems—The case of Denmark in years 2030 and 2050. *Energy* (2008), doi:10.1016/j.energy.2008.04.003
3. Danish Government, *Rapport fra regeringens planlægningsudvalg for vindmøller på land* (Report of the governmental planning committee for onshore wind turbines), 2007. (Retrieved

May 4, 2009 from: http://www.skovognatur.dk/NR/rdonlyres/DD516ABE-42D2-49C9-99EA-07DE3EBEDC0C/40309/endeligrapport020207.pdf)
4. IDA, *Ingeniørforeningens Energiplan: Hovedrapport* (The Danish Society of Engineers' Energy plan 2030: Main Report), 2006.
5. Danish Energy Agency, *Energy Statistics 2007*, 2008. (Retrieved May 4, 2009 from: http://www.ens.dk/graphics/UK_Facts_Figures/Statistics/yearly_statistics/2007/energy%20statistics%202007%20uk.pdf)
6. Möller, B., Changing wind-power landscapes: regional assessment of visual impact on land use and population in Northern Jutland, Denmark, *Applied Energy*, vol. 83, no. 5, pp 477-494, 2006.
7. Bijker, W., Hughes, T., and Pinch, T., *The Social Construction of Technological Systems*, Cambridge, MIT Press, 1987.
8. Weaver, P., Jansen, L., van Grootveld, G., van Spiegel, E. and Vergragt, P., *Sustainable Technology Development*. Sheffield (UK), Greenleaf Publishing Limited, 2000.
9. Toke, D, Wind Power in the UK and Denmark: Can Rational Choice Help Explain Different Outcomes?, *Environmental Politics* 11 (4): pp 83-100, 2002.
10. Wolsink, M., Planning of renewables schemes: Deliberative and fair decision-making on landscape issues instead of reproachful accusations of non-cooperation, *Energy Policy* 35 (2007): pp 2692-2704, 2007.
11. Wüstenhagen, R., Wolsink, M. and Bürer, M. J., Social acceptance of renewable energy innovation: An introduction to the concept, *Energy Policy* 35 (2007): pp 2683-2691, 2007.
12. Mathiesen, B.V. and Lund, H., Comparative analyses of seven technologies to facilitate the integration of fluctuating renewable energy sources, *Submitted for IET Renewable Power Generation (Status: accepted)*, 2008.
13. Blarke, M. B. and Lund, H., The effectiveness of storage and relocation options in renewable energy systems, *Renewable Energy*, vol. 33, no. 7, pp 1499-1507, 2008.
14. Mendoca, M., Lacey, S. and Hvelplund, F., Stability, participation and transparency in renewable energy policy: Lessons from Denmark and the United States, *Policy and Society* 27 (2009) pp 379-398, 2009.
15. Hvelplund, F., Renewable energy and the need for local energy markets, *Energy*, vol. 31, no. 13, pp 2293-2302, 2006.
16. Danish Government, *Agreement between the government (Liberals and Conservatives), Social Democrats, Danish People's Party, Socialist People's Party, Social Liberals and New Alliance on Danish energy policy for the years 2008-2011*, 2008.
17. Klima- og Energiministeriet, LOV nr 1392 af 27/12/2008, *Lov om Vedvarende Energi* (Ministry of Climate and Energy: Law on Renewable Energy), 2008.
18. Danish Wind Turbine Owners' Association, *Faktablad 11: Udskiftning af Vindmøller* (Factsheet 11: Repowering of Wind Turbines), 2004.
19. Kamp, L.M., Smits, R.E.H.M. and Andriesse, C.D., Notions on learning applied to wind turbine development in the Netherlands and Denmark, *Energy Policy* 32 (2004): pp 1625-1637, 2004.
20. Toke, D., Community wind power in Europe and the UK, *Wind Engineering* 29 (3): pp 301-308, 2005.
21. Wolsink, M., Wind power implementation: The nature of public attitudes: Equity and fairness instead of 'backyard motives', *Renewable & Sustainable Energy Reviews* 11 (2007): pp 1188-1207, 2007.
22. Miljøministeriet, BEK nr 1335 af 06/12/2006, *Bekendtgørelse om vurdering af visse offentlige anlægs virkning på miljøet (VVM) i medfør af lov om planlægning* (Ministry of the

Environment: Executive Order regarding the Environmental Impact Assessment (EIA) of certain public installations pursuant to the Planning Act), 2006.
23. Danish Wind Turbine Owners' Association, *Faktablad 2: Planlægning for Vindmøller* (Factsheet 2: Planning for Wind Turbines), 2008.
24. Nordjyllands Amt, *Regionplantillæg nr. 198. Regionplantillæg for vindmølleplanlægning i Nordjyllands Amt: "Skrotning af uheldigt opstillede vindmøller og opstilling af erstatningskapacitet i Nordjyllands Amt – 2. skrotningsordning"* (Regional plan amendment no. 198. Regional plan amendment for wind turbine planning in the county of Northern Jutland: "Dismantling of inappropriately placed wind turbines and installation of replacement capacity in the county of Northern Jutland – 2nd repowering scheme"), 2006.
25. Bell, D., Gray, T. and Haggett, C., The 'Social Gap' in Wind Farm Siting Decisions: Explanations and Policy Responses, *Environmental Politics* 14 (4): pp 460-477, 2005.
26. Devine-Wright, P., Beyond NIMBYism: towards an Integrated Framework for Understanding Public Perceptions of Wind Energy, *Wind Energy* (2005) 8: pp 125-139, 2005.
27. Organisation for Vedvarende Energi (OVE), *OVE's høringssvar vedrørende: "Udkast til "Cirkulære om planlægning for og landzonetilladelse til opstilling af vindmøller" med tilhørende vejledning. Journalnummer BLS-145-00082* (Organisation for Renewable Energy's hearing statement regarding "Draft of "Circular on planning and rural area permission for installation of wind turbines" including appertaining instructions), 2008.
28. Vindmølleindustrien, *Revideret udkast til nyt vindmøllecirkulære og vejledning* (Hearing statement of the Danish Wind Industry Association regarding the revised draft of new wind turbine circular and instructions), 2009.
29. Mæng, H., *Beskæftigelses- og Eksportvirkninger ved Dansk Energipolitik – Eksemplificeret ved vindkraft, solvarme, biogas samt decentral kraftvarme på naturgas* (Effects of Danish Energy Policy on Employment and Export – Exemplified in the case of wind power, solar heating, biogas and decentralised combined heat and power using natural gas), Aalborg University, Department of Development and Planning, Instituttets skriftserie nr. 223, 1998.